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I HEREBY CERTIFY that annexed hereto is a true copy of documents filed in connection with the following patent application:

Application No.	2002/0655
Date of Filing	6 August 2002
Applicant	XSIL TECHNOLOGY LIMITED, an Irish Company of Unit 2, Trinity Enterprise Centre, Pearse Street, Dublin 2, Ireland.

Dated this 18th day of August 2003.

An officer authorised by the
Controller of Patents, Designs and Trademarks.

FORM NO. 1

APPLICATION No. 020655

REQUEST FOR THE GRANT OF A PATENT

PATENTS ACT, 1992

The Applicant(s) named herein hereby request(s)

__X__ the grant of a patent under Part II of the Act

_____ the grant of a short-term patent under Part III of the Act

on the basis of the information furnished hereunder.

1. Applicant(s)

Name: Xsil Technology Limited

Address: Unit 2
Trinity Enterprise Centre
Pearse Street
Dublin 2
Ireland

Description/Nationality: An Irish company

2. Title of Invention

"A laser machining method and apparatus"

3. Declaration of Priority on basis of previously filed application(s) for same invention (Sections 25 & 26)

Previous filing date	Country in or for which filed	Filing No.

4. Identification of Inventor(s)
Name(s) of person(s) believed
by Applicants(s) to be the inventor(s)

BOYLE, ADRIAN
an Irish citizen of
9 Togher Grove, Monasterevin, County Kildare, Ireland

FARSARI, MARIA
a citizen of
1 Seamount House, St. John's Road, Sandymount, Dublin 4, Ireland

5. Statement of right to be granted a patent (Section 17(3))

The Applicant derives the rights to the Invention by virtue of a Deed of Assignment dated August 2, 2002

6. Items accompanying this Request – tick as appropriate

(i) __X__ prescribed filing fee (EUR125.00)

(ii) __X__ specification containing a description and claims

_____ specification containing a description only

__X__ Drawings referred to in description or claims

(iii) _____ An abstract

(iv) _____ Copy of previous application(s) whose priority is claimed

(v) _____ Translation of previous application whose priority is claimed

(vi) __X__ Authorisation of Agent (this may be given at 8 below if this Request is signed by the Applicant (s)

7. Divisional Application (s)

The following information is applicable to the present application which is made under Section 24 –

Earlier Application No: .....

Filing Date: .....

8. Agent

The following is authorised to act as agent in all proceedings connected with the obtaining of a patent to which this request relates and in relation to any patent granted -

Name	Address
John A. O'Brien & Associates	The address recorded for the time being in the Register of Patent Agents, and currently Third Floor, Duncairn House, 14 Carysfort Avenue, Blackrock, Co. Dublin, Ireland.

9. Address for Service (if different from that at 8)

As above

Signed _____ JOHN A. O'BRIEN & ASSOCIATES

Date August 6, 2002

"A laser machining method and apparatus"

Introduction

The invention relates to laser machining of bodies containing at least a significant proportion of silicon.

Silicon reacts vigorously with all the halogens to form silicon tetrahalides. So, it reacts with fluorine, F_2, chlorine, Cl_2, bromine, I_2, and iodine, I_2, to form respectively silicon fluoride, SiF_4, silicon chloride, $SiCl_4$, silicon bromide, $SiBr_4$, and silicon iodide, SiI_4. The reaction with fluorine takes place at room temperature but the others requiring warming over 300°C.

$Si + F_2 = SiF_4$ (gas)

$Si + Cl_2 = SiCl_4$ (gas)

It is also known from literature [1], [2] that the presence of halocarbons accelerates the ablation of silicon. An example of a halocarbon-silicon reaction is,

$Si + CF_4 = SiF_4$ (gas) + C (solid)

The reaction between halocarbons and silicon is not spontaneous. It occurs only at energies above the melting threshold of silicon, and therefore is very localized and suitable for one-step silicon micro-machining applications such as wafer dicing, vias and surface patterning.

[1] Russell, S. D., D. A. Sexton, et al. (1993, Nov. 30). Method for laser-assisted silicon etching using halocarbon ambients. United States Patent 5, 532. USA, The United States of America as represented by the Secretary of the Navy (Washington, DC).

[2] Russell, S.-D., D. A. Sexton, et al. (1994, June 21). Laser texturing. United States Patent 5, 988. USA, The United States of America as represented by the Secretary of the Navy (Washington, DC).

The invention is directed towards providing for enhanced machining of silicon

Statements of Invention

According to the invention, there is provided a method of machining a silicon body, comprising the step of directing a laser beam at the body, wherein the body is machined in the presence of a halocarbon, and the laser intensity is such as to cause sufficient temperature elevation for a reaction between the silicon and the halocarbon locally at the machining location.

In one embodiment, the laser beam is in the UV wavelength range.

In one embodiment, the laser beam is in the green wavelength range.
In one embodiment, the halocarbon is in a refrigerated liquid form.

In one embodiment, the halocarbon is selected from the group of fluorine, F_2, chlorine, Cl_2, bromine Z_2, iodine I_2.

The invention also provides a laser machining apparatus comprising means for directing a laser beam and an environmental chamber comprising means for providing a controlled halocarbon environment around at least a machining site of a silicon body.

In one embodiment, the environmental chamber comprises a bath for refrigerated liquid halocarbon.

In one embodiment, the chamber comprises an inlet and an outlet for the liquid halocarbon, and a gas vent.

In one embodiment, the environmental chamber comprises a silica glass window for the laser beam.

In one embodiment, the window is anti-reflection coated.

Detailed Description of the Invention

The invention will be more clearly understood from the following description of some embodiments thereof, given by way of example only with reference to the accompanying drawings in which:-

Fig. 1 is a perspective view of a laser machining apparatus; and

Fig. 2 is a plan view of the apparatus.

Referring to Figs. 1 and 2, a laser machining apparatus 1 comprises a stainless steel enclosure 2 having a liquid inlet 3, a liquid outlet 4, and a gas vent 5. An optical system 10 is mounted above the enclosure. An enclosed liquid bath is completed by an anti-reflection coated silica glass window 15 to allow access of a UV laser beam to a silicon wafer W in the bath.

In use, the wafer W is placed in the enclosure 2 and a refrigerated liquid halocarbon such as tetrafluoroethane is pumped into the bath via the inlet 3. The inlet 3 and the outlet 4 are in a refrigeration circuit so that the liquid temperature is maintained at or below the gas transition temperature of the particular halocarbon. The bath is filled with the liquid.

The UV beam is directed at the desired machining site on the wafer W for the desired machining operation. Locally, at the machining site, the laser beam heats the silicon so that the immediately surrounding liquid is both brought above the gas transition temperature, and the temperatures of both the silicon and the gas are sufficient for a reaction to take place. In this situation most of the by-products are gases and are vented away. Those which are solid particles are dispersed in the liquid and are not re-deposited onto the wafer surface.

Thus, it will be appreciated that the invention provides for very efficient and high quality laser machining.

The invention is not limited to the embodiments described but may be varied in construction and detail. For example, the liquid may comprise mixtures of halocarbons and other liquids. Also, the chamber may be partly filled with a refrigerated halocarbon liquid and the remainder filled with a gas. Also not only UV, but also green lasers can be used. Also there can be more than one inlet, to allow the insertion of other liquids or gases

Claims

1. A method of machining a silicon body, comprising the step of directing a laser beam at the body, wherein the body is machined in the presence of a halocarbon, and the laser intensity is such as to cause sufficient temperature elevation for a reaction between the silicon and the halocarbon locally at the machining location.

2. A method as claimed in claim 1, wherein the laser beam is in the UV wavelength range.

3. A method as claimed in claim 1, wherein the laser beam is in the green wavelength range.

4. A method as claimed in any preceding claim, wherein the halocarbon is in a refrigerated liquid form.

5. A method as claimed in any preceding claim, wherein the halocarbon is selected from the group of fluorine, F_2, chlorine, Cl_2, bromine Z_2, iodine I_2.

6. A method of machining a silicon by substantially as described with reference to the drawings.

7. A laser machining apparatus comprising means for directing a laser beam and an environmental chamber comprising means for providing a controlled halocarbon environment around at least a machining site of a silicon body.

8. A laser machining apparatus as claimed in claim 7, wherein the environmental chamber comprises a bath for refrigerated liquid halocarbon.

9. A laser machining apparatus as claimed in claim 8, wherein the chamber comprises an inlet and an outlet for the liquid halocarbon, and a gas vent.

10. A laser machining apparatus as claimed in any of claims 7 to 9, wherein the environmental chamber comprises a silica glass window for the laser beam.

11. A laser machining apparatus as claimed in claim 10, wherein the window is anti-reflection coated.

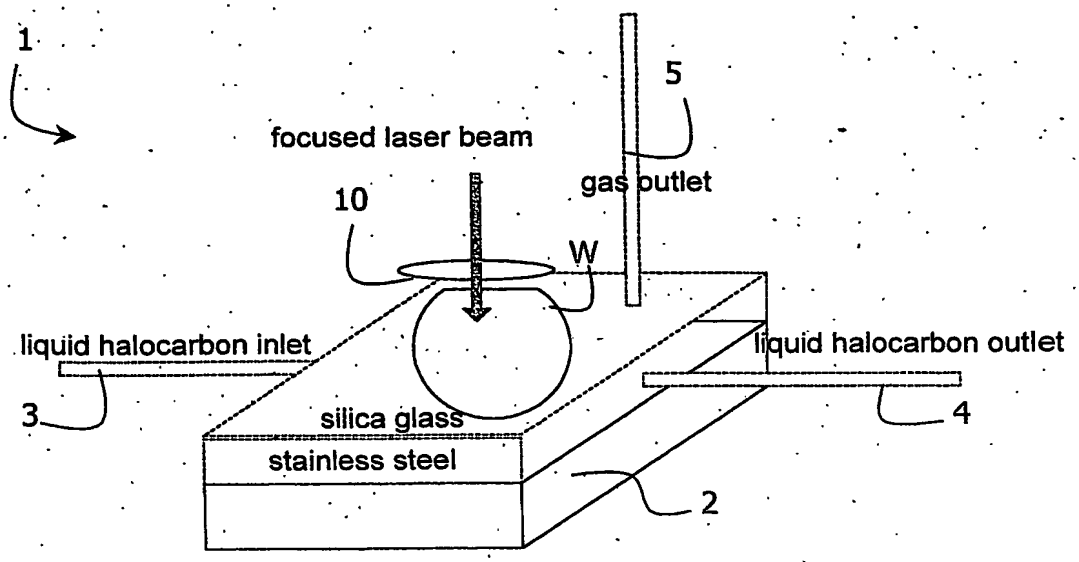
1
5
focused laser beam
gas outlet
10
W
liquid halocarbon inlet
liquid halocarbon outlet
3
4
silica glass
stainless steel
2

Fig. 1

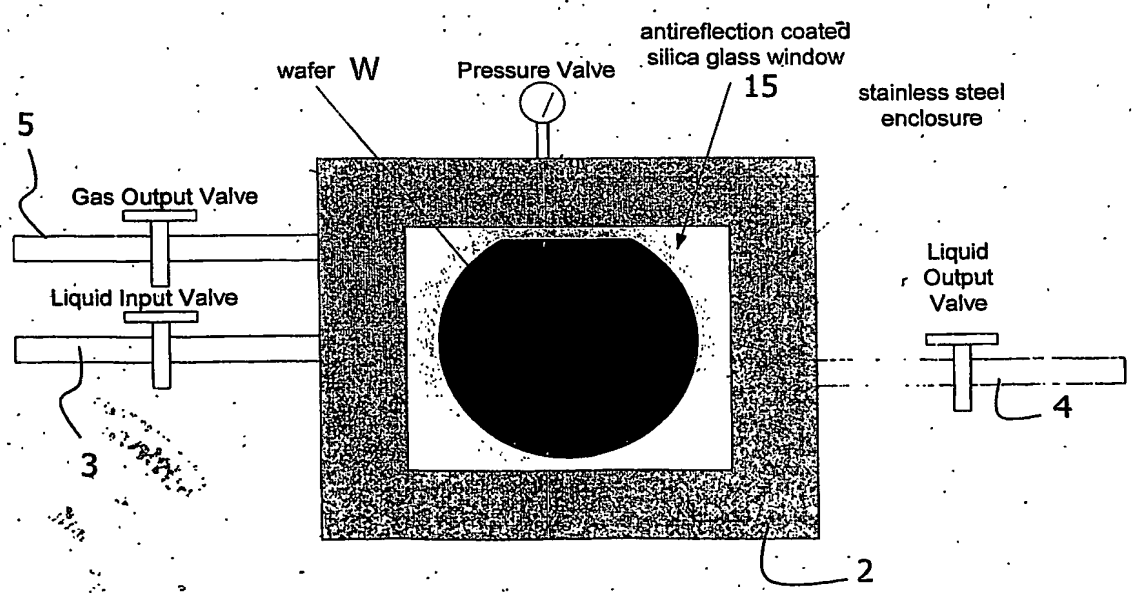
wafer W
Pressure Valve
antireflection coated
silica glass window
15
stainless steel
enclosure
5
Gas Output Valve
Liquid Input Valve
Liquid
Output
Valve
3
4
2

Fig. 2

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